THE

SCIENTIFIC PROCEEDINGS

OF THE

ROYAL DUBLIN SOCIETY

VOL. 25 (N.S.).

No. 8. JULY, 1949.

A FURTHER EXPERIMENT ON THE EFFECT OF MILD STRAINS OF VIRUS X ON THE YIELD OF UP-TO-DATE POTATO.

BY PHYLLIS E. M. CLINCH AND ROBERT MCKAY.

DUBLIN :
PUBLISHED BY THE ROYAL DUBLIN SOCIETY.
BALLSBRIDGE, DUBLIN.
HODGES, FIGGIS, AND CO.,
6 DAWSON STREET, DUBLIN.
WILLIAMS AND NORGATE,
36 GREAT RUSSELL STREET, LONDON, W.C.1
1949.

Price ; One Shilling and Sixpence

...ALTH MYCOLOGICAL INSTITUTE
31 AUG. 1949

No. 8

A FURTHER EXPERIMENT ON THE EFFECT OF MILD STRAINS OF VIRUS X ON THE YIELD OF UP-TO-DATE POTATO.

By

PHYLLIS E. M. CLINCH AND ROBERT McKAY.

[Read April 26, 1948. Published July 28, 1949.]

Introduction.

In a previous experiment (7), carried out in 1946, it was found that the yields of Up-to-Date potato plants were not significantly reduced as a result of infection with mild strains of virus X, but in certain cases actually showed a slight increase in yield over those of healthy plants of the same clone. Weather conditions in that year were, however, somewhat abnormal, a period very favourable for growth in May and June being followed by excessively wet and stormy weather during the remainder of the season. Due to the continuous rain and lack of sunshine senescence was retarded, and the plants were still immature when killed by Blight (*Phytophthora infestans*) towards the end of September. As previous investigators (3), (9), had recorded a reduction in yield due to infection with virus X, it was concluded that the premature killing of the plants was probably responsible for this unexpected result.

The present paper is an account of a similar yield trial carried out in 1948.

Experimental Procedure.

The Up-to-Date used belonged to the same stock as was employed in the 1946 trial. All the material had been propagated originally from two virus-free tubers of the variety, so that two different clonal lines were available for test. One-third of each clone had been maintained in a virus-free condition, one-third infected with virus X strain (*a*) and the remaining fraction with virus X strain (*b*). The letters (*a*) and (*b*) have no other significance than to distinguish the two strains of X. Details regarding these strains have been furnished in the previous report (7), and it will suffice to say here that both are carried symptomlessly by Up-to-Date, and both were originally found occurring naturally in this variety.

The material for the 1948 experiment was propagated during 1947 in isolated field plots amongst corn. It included, besides the healthy and X-infected units of the two experimental clones of Up-to-Date, an appropriate quantity of virus-free Majestic for bordering purposes, and also samples of the two clones of Up-to-Date from which the strains of mild X were derived. (The stocks of the latter have been propagated under glass at Glasnevin for the past 25 years, and during that time

no change has been detected in the appearance of the plants, nor have innumerable inoculations to other solanaceous hosts revealed any variation in intensity of the virus strains present). All the Up-to-Date tubers, except those of the sources of X strains, were tested in the first instance by growing a core from each in the glasshouse in early Spring and inoculating the resulting plants with a severe strain of virus X. The healthy plants reacted with local necrotic lesions followed by systemic mosaic, while the X-infected plants remained unchanged. In this way the absence of X in the units to be propagated as healthy material and its presence in those which were to produce infected material was confirmed. The tubers were planted on May 9th, and the plots were kept under close observation throughout the growing season. No signs of infection with extraneous viruses were observed. On September 2nd the healthy Up-to-Date and Majestic plants were tested for freedom from virus X. Leaflets were taken from alternate plants in each drill and those from groups of four plants were combined and the sap inoculated to *Datura stramonium* in the glasshouse. No symptoms resulted from these inoculations. The tubers were lifted in October, and were all stored under the same conditions during the Winter. It was considered unnecessary to disinfect them against Blight as owing to the exceptionally fine weather during the latter part of the season the foliage had escaped the disease.

The different lots included in the 1948 test were as follows:

(1) Up-to-Date. Clone I — Healthy
(2) ,, ,, ,, — Infected X Strain (*a*)
(3) ,, ,, ,, — Infected X Strain (*b*)
(4) ,, Clone II — Healthy
(5) ,, ,, ,, — Infected X Strain (*a*)
(6) ,, ,, ,, — Infected X Strain (*b*)
(7) ,, — Source of strain (*a*)
(8) ,, — Source of strain (*b*)

The layout of the experiment was in the form of a 7×7 Latin square, in which 15 plants constituted a block. As the supplies of tubers of the Up-to-Date sources of X strains (*a*) and (*b*) were in neither case sufficient to plant 7 blocks of 15 plants each, these two lots were combined and treated as one lot for the purpose of plot analysis. The tubers, however, were not mixed indiscriminately but were planted in order in approximately equal numbers within the blocks. There were thus 49 blocks in all, 42 of which were planted with lots 1 to 6 and the remaining 7 with the combined lots 7 and 8. To prevent infection by contact each block was bordered on all sides by plants of virus-free Majestic, and the plot as a whole was bounded by three rows of the same variety in order to eliminate border effects.

The plot was situated on a level piece of ground in which potatoes had not been grown for at least 20 years. The drills were 30 ins. apart, and were manured with farmyard manure and the usual artificials. The tubers were set 18 in. apart in the drills. Planting took place on April 7th, and only whole sets of normal seed size (average weight about 3 oz.) were used. From the time the plants came above ground at the end of April there was little or no frost, and hence no check in growth

due to this cause. Warm weather from about April 20th to May 20th was followed by a cool wet period up to June 23rd. Subsequently, temperatures were higher without any period of drought. Weather conditions generally were such that the plants grew steadily and uninterruptedly during the entire season, and this was reflected in high yields at Glasnevin and throughout the country generally.

The plants were sprayed with 2% Burgundy mixture on June 24, and again on July 28. In the beginning of June and thereafter at regular intervals during the growing season all plants were carefully scrutinized for disease symptoms. No trace of leaf roll or other virus infection was observed, and no difference could be detected between the various experimental lots of Up-to-Date, all of which appeared to be uniformly vigorous. Towards the end of July leaflets which had withered due to *Botrytis cinerea* were observed here and there throughout the plot. Blight (*Phytophthora infestans*) was first noticed on August 18, but due to the somewhat cold weather the attack remained slight until the middle of September when, following a week of heavy rain, the disease became rampant over the plot. On October 4 practically all the foliage had been killed. The tubers were dug on October 14, and the separate lots taken indoors in sacks. Adhering soil was removed and ware, seed, and chats, were weighed separately. The results are shown in Table 1.

DISCUSSION OF RESULTS.

The total yield of the 735 Up-to-Date plants in the plot was 3,675 lbs. 8 ozs. and the average yield per plant was 5 lbs. which is equivalent to a yield of almost 26 tons per statute acre. The healthy plants of clones I and II gave average yields of 5 lbs. 3 oz. and 5 lbs. per plant, respectively. These high yields indicate how much more favourable were environmental conditions in 1948 than in 1946, when the average yields of the healthy plants of the 2 clones were 3 lbs. 6 oz. and 3 lbs. 10 oz., respectively.

As previously mentioned, the plants in the 1946 experiment were still immature when killed by Blight. Bald (5) had demonstrated that the falling off in yield of X-infected plants which occurred in his experiments was due to a reduction in the rate of tuberation in the final stages of growth. Consequently, in order to explain the slight increase in yield of X-infected plants over healthy ones found in the 1946 trial at Glasnevin, it was suggested that the diseased plants had set tubers earlier than the healthy ones and that the slower rate of tuberation in the final stages of growth, which in a normal year would have more than offset this initial advantage, had not been operative owing to the premature killing of the plants. It was expected that in a season of uninterrupted growth, such as occurred in 1948, the yield of the diseased plants would have been lower than that of the healthy controls. This expectation was only fulfilled in the case of clone I, the plants infected by X strains (*a*) and (*b*) yielding 12% and 8%, respectively, less than the healthy plants of the clone. Statistical analysis of the results showed the standard error of a group of 7 plots to be ± 5.8, so that differences greater than 7% between the yields

TABLE I.

Comparative Yields of Healthy and X-infected Up-to-Date Potato Plants, 1948

	No. of Plants	Ware	Seed	Chats	Total Yield	Approx. yield per st. acre	Av. yield per plant	Yield as per centage of healthy.
CLONE I.								
		lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	Tons	lbs. oz.	
Healthy	105	456 0	70 8	19 8	546 0	27	5 3	100
Infected Strain (a)	105	387 8	71 8	21 0	480 0	24	4 9	88
Infected Strain (b)	105	411 0	70 8	21 0	502 8	25	4 12	92
CLONE II.								
Healthy	105	435 0	73 8	21 0	529 8	26	5 0	100
Infected Strain (a)	105	448 8	70 8	16 8	535 8	26	5 1½	101
Infected Strain (b)	105	475 8	60 8	17 0	553 0	27	5 4	104
UP-TO-DATE SOURCES OF X STRAINS (a) AND (b)								
Strain (a)	54	220 8	34 8	10 8	265 8	25½	4 14½	*(I) 94.5 (II) 97
Strain (b)	51	216 8	40 0	8 0	264 8	27	5 3	(I) 100 (II) 103
Strains (a) and (b) combined	105	437 0	74 8	18 8	530 0	26	5 0	(I) 97 (II) 100

* Double sets of figures represent yields as percentages of healthy plants of clones (I) and (II).

of the healthy and diseased lots are significant. In the case of clone II, however, both lots of infected plants gave insignificantly higher yields than the healthy controls, and the plants infected with X strain (*b*) gave the highest yield in the test. The total yield of the 105 healthy plants of this clone differed by only 3% from that of the healthy plants of clone I.

As in the previous experiment, the Up-to-Date sources of X strains (*a*) and (*b*) yielded surprisingly well. The total yield of the 105 plants of these two stocks combined was 530 lbs. which is 97% that of the healthy plants of clone I and 100% that of the healthy plants of clone II. The source of strain (*a*) gave an average yield per plant of 4 lbs. 14½ oz. and that of strain (*b*) 5 lbs. 3 oz. Calculating the yields as percentages of the healthy plants of clones I and II, the figures are 94.5 and 97, respectively, for the stock infected strain (*a*) and 100 and 103 respectively, for that infected strain (*b*). None of these differences is significant.

The inferences to be drawn from these results, coupled with those of 1946, are that in respect of cropping capacity different clones of a potato variety react differently to infection with the mild strains of virus X used. In the case of certain clones the presence of the virus has no appreciable effect on yield whether the season is a favourable or unfavourable one for growth. On the other hand, the nature of the reaction apparently can be determined by environmental conditions, as in the case of clone I, the infected plants of which yielded significantly lower than the healthy controls in 1948, but gave approximately equal or higher yields in 1946.

Discussing the importance of virus X in the growing of potatoes a short time ago Smith and Markham (9) stressed the necessity for knowing whether those strains of the virus which have little or no adverse effect upon the plant itself materially reduce the yield. On the basis of Bald's (3) results and those of a yield trial performed at Cambridge, in which a very mild strain of X was found to cause a highly significant reduction in yield, these authors concluded that a considerable loss of crop is effected by even the mildest strains of virus X. So far this view has not been challenged by other investigators in these islands. However, the results obtained at Glasnevin suggest that the effects of mild strains of X on yield may be much less serious here than in Australia, which is not altogether surprising considering that environmental conditions differ so widely in the two regions. Similar indications are to be found in yield trials carried out recently in England and Scotland. Bawden, Kassanis, and Roberts (6), in an experiment performed at Rothamsted in 1946, estimated the effects of different strains of X (including two strains which probably correspond to those used at Glasnevin) on yields of the varieties Majestic and Arran Banner. In only one case did infection with the milder strains of X cause a significant reduction in yield. Moreover, Scotch stock seed Majestic, which appeared healthy but was actually infected with an avirulent strain of X, yielded 10% higher than virus-free Majestic, which increase, however, was not statistically significant. One explanation of the latter result put forward by Bawden and his co-workers was that the virus-free stocks " were suffering from the effects of continued propagation under glass, and that longer than one year in the field may be needed to mitigate this condition." It is not stated on what evidence is based the assumption that

tubers from plants raised in a glasshouse normally yield less than those from outdoor plants when both are grown under similar conditions in the field. The results of the present work are not favourable to this theory, for the stocks of Up-to-Date used gave an average yield of 5 lbs. per plant in their first year out-of-doors in 1945, which is the same as the average yield obtained in the favourable season of 1948, the stocks having been propagated out-of-doors in the meantime. In a preliminary yield trial carried out in Scotland in 1947 it was found that infection with mild strains of X in the two varieties Majestic and Kerr's Pink led to higher yields than in the uninfected controls (1). This result was attributed to the abnormally dry season, which led to premature ripening and so affected yields generally, although according to a report from Australia (2) healthy plants withstand drought better than X-infected ones. In correspondence Dr. Cockerham states that when the experiment was repeated in 1948, all the infected stocks yielded less than the healthy controls, but details of this work are not yet available. It is doubtful if any precise information regarding the effect of mild strains of X on cropping capacity can be derived from the original Scottish yield trials performed by Scott (8). Apart from the fact that his controls are believed to have been carriers of X (9), the plants of his "negligible mottle" group could have been infected with either mild X or virus A. As there is no justification for assuming that the effect of virus A on yield is similar to that of X strains causing a mottling of equivalent intensity in the foliage, it is difficult to see how any deductions regarding mild X alone can be made from the yields of Scott's "negligible mottle" group.

Unfortunately, due allowance for variations amongst clones of a given potato variety has not been made in the English and Scottish yield trials so far described, although Bawden and his co-workers (6) refer to the possible existence of differences of vigour and cropping power within potato varieties. Bald (4) (5) drew attention in 1944 to the existence of agronomic differences between different clonal lines of the variety Up-to-Date, and demonstrated that the yields of various X-free clones differed significantly when grown under the same conditions. He also observed that a virus-free clone which gave a comparatively low yield at Canberra tended to be the highest-yielding of all clones in New South Wales. In addition, evidence is now presented that the reactions of different clonal lines to virus X vary significantly and may be affected by environmental conditions. It is obvious, therefore, that further experiments, in which the clonal variation factor is controlled, must be performed before any conclusive statement regarding the effect of mild strains of virus X on the cropping capacity of potatoes in these islands can be made.

Summary.

A field trial was conducted in 1948 to test the effect of two different mild strains of virus X on the cropping capacity of Up-to-Date potato.

The test was made with healthy and X infected plants of two different clones of Up-to-Date derived originally from two virus-free tubers of this variety. Also included in the trial were the two infected stocks of Up-to-Date from which the strains of X used had been isolated. Weather conditions throughout the period of

the trial were especially favourable to potatoes, and the average yield per healthy plant was 5 lbs. 2 oz., which is equivalent to 26½ tons per statute acre.

The yields of the healthy plants of the two principal experimental clones differed by 3%, which is insignificant. Both strains of X caused a significant reduction in yield of the plants of clone I. The infected plants of clone II, however, yielded as well as the virus-free controls. The yields of the Up-to-Date sources of the X strains did not differ significantly from those of the healthy plants of the experimental clones I and II.

In a previous experiment on similar lines, carried out in 1946, no reduction in yield due to infection with mild strains of X had occurred. In that year the plants were immature when killed by Blight (*Phytophthora infestans*), and the average yield per healthy plant was only 3 lbs. 8 oz.

The results so far available indicate that in so far as cropping capacity is concerned different clones of a potato variety react differently to infection with mild strains of virus X; and that in some cases the nature of the reaction may be considerably affected by environmental conditions.

Grateful acknowledgement is made to Mr. P. T. Carroll, M.Agr.Sc., for his advice and assistance in regard to statistical analysis of the results.

REFERENCES.

(1) ANON.——Rept. of Scottish Soc. for Research in Plant-breeding, 29th July, 1948. p. 20.

(2) ANON.——Seventeenth Ann. Rept. Commonwealth Counc. Sci. Ind. Res. year ended 30th June, 1943. (1944).

(3) BALD, J. G.—Potato virus X. Mixtures of strains and the leaf area and yield of infected potatoes. Counc. Sci. Ind. Res. Bull. No. 165, 1943.

(4) ———— Progress of work with potato stocks free from virus X (FX potatoes). J. Counc. Sci. Ind. Res. **17**: pp. 258-263, 1944.

(5) ———— Development of differences in yield between FX and virus X-infected Up-to-Date potatoes. *Ibid.*, **17**: pp. 263-273, 1944.

(6) BAWDEN, F. C., KASSANIS, B., and ROBERTS, F. M.—Studies on the importance and control of potato virus X. Ann. App. Biol. **35**: pp. 250-265, 1948.

(7) CLINCH, P. E. M. and MCKAY, R.—Effect of mild strains of virus X on the yield of Up-to-Date potato. Sci. Proc. Roy. Dublin Soc. **24**: pp. 189-198, 1947.

(8) SCOTT, R. J.—The effect of mosaic diseases on potatoes. Scott. Journ. Agr. **23**: pp. 258-264, 1941.

(9) SMITH, K. M. and MARKHAM, R.—Importance of potato virus X in the growing of potatoes. *Nature*, Jan. 13, 1945.